METHOD FOR MANUFACTURING A LAMP ELECTRODE

BACKGROUND OF THE INVENTION

Field of the Invention

The invention pertains to the art of manufacturing processes. It finds application in the manufacture of electrodes for lamps and in particular in the manufacture of electrodes for ceramic metal halide lamps.

Discussion of the Art

A current method of manufacturing electrodes for ceramic metal-halide lamps uses fixtures with precision v-slots and spring clamps to align component wire axes. These fixtures are difficult to manufacture with a level of precision needed to meet product requirements. Furthermore, each product type requires a custom-built fixture to handle different wire diameters. Additionally, each component of the electrode must be pre-cut to length, singulated, and fed into the fixture from the side, contributing to the complexity of a feeding system.

Another problem with the existing process is the manufacture and handling of electrode components, namely electrode tips. It is believed that these tips are manufactured by hand. The tips are expensive. Furthermore, new low-wattage products will require even smaller electrodes. Current manufacturing techniques appear unable to accommodate the requisite smaller size.

Once the tips are manufactured, they must be separated and delivered to an assembly fixture. The current handling process involves bowl feeding electrode tips, molybdenum overwinds and niobium wire shanks into vibratory tracks. The tracks deliver the electrode components or parts to an escapement where they are removed by a vacuum pick-and-place device. The pick-and-place device orients and delivers the parts into assembly fixtures where they are welded together. This technique works reasonably well for tips with shank diameters larger than 0.010";

however, it is increasingly more difficult to separate, pickup, and orient the tips in an assembly fixture as the tips get smaller.

To date, available lamp electrode manufacturing techniques are unable to accommodate the reduced size of electrodes needed for low wattage lamps. Additionally, available manufacturing techniques are too expensive to be useful in a high-volume manufacturing environment necessary to make manufacture and sale of low wattage lamps practical. Thus, the need exists to provide a method for manufacturing electrodes for lamps that is fast, inexpensive, and amenable to high production volumes.

BRIEF SUMMARY OF THE INVENTION

An exemplary method for making a lamp electrode is suitable for automation and adaptable for use on a machine tool. The method comprises the steps of cutting a first material having a first end, to a desired length, thereby defining a second end, welding a first end of a second material to the second end of the first material, cutting the second material to define a second end of the second material, welding a first end of a third material to the second end of the second material, cutting the third material to define a second end of the third material, and securing a coil to the second end of the third material.

One advantage of the present invention is that it can be implemented on a machine tool.

Another advantage of the present invention is that it allows for the manufacture of electrode components with very low unit-to-unit dimensional variation.

A further advantage of the present invention is that it provides for precise electrode component alignment while eliminating the need for custom fixtures.

Still another advantage of the present invention is that it provides for the rapid and inexpensive manufacture of electrodes.

Another advantage of the present invention is that it provides for the manufacture of extremely small electrodes.

BRIEF DESCRIPTION OF THE DRAWINGS

FIGURES 1–24 are elevational views of sequential steps of making a lamp electrode, where collets are shown in longitudinal cross-section for ease of illustrating components and subassemblies of the lamp electrode.

FIGURE 25 is an enlarged elevation with selected components in partial cross-section showing engagement of a third material component and a coil facilitated by spinning and without the use of a guide.

DETAILED DESCRIPTION OF THE INVENTION

The present invention relates to a method for manufacturing an electrode. A conventional electrode used in a ceramic metal halide lamp, for example, includes a tungsten tip (a tungsten shank having a tungsten coil), a molybdenum overwind, and a niobium wire joined in end-to-end fashion. The electrode can be manufactured in numerous ways. The preferred embodiment uses a machine tool to carry out various steps. Machine tools are well suited to carrying out steps of the present invention because they can align parts extremely precisely and with a high degree of repeatability. Machine tools can also be loaded with bulk supplies of raw materials, such as, for example, long shanks and/or spools of wire. An example of an appropriate machine tool for performing steps of the present invention is a Swiss turning machine. Swiss turning machines are normally used for machining of small metal parts. Such a machine is capable of performing operations such as those required by the present invention. The invention will be described in relation to its implementation on such a machine tool.

Referring now to FIGURE 1, a first **40** and a second **44** collet, which can be part of a machine tool (not shown), are positioned in an axially aligned, facing relation. The second collet **44** is associated with a supply of a first material **48**, for example, niobium wire used to make a lamp electrode. A leading or first end **52** of the first material **48** is presented by the second collet and is located at a reference point **56**. The first end **52** is positioned at the reference point **56** by conventional means. Such conventional means include sensing the position of the end (using optical, electrical or mechanical means) or by cutting the end at a known location. Subsequent material and collet movements are based on the reference position.

Subsequent to referencing, the first material **48** is advanced or indexed a predetermined distance **60** into the first collet **40** (FIGURE 2). The predetermined distance **60** is a function of a desired length for a first material component of the electrode.

The first material **48** is cut at a predetermined location **64** (FIGURE 3) which is also a function of the desired length for the first component **62** of the electrode. Cutting is preferably done with a diamond saw **68**. Other cutting techniques can be used, although using the diamond saw **68** is preferred since it eliminates the need for secondary cleanup and polishing operations.

Referring now to FIGURES 4 and 5, the first collet **40** holds the first material component **62**, and the second collet **44** is indexed out of position or removed from its facing relation with the first collet. Thus, the first material, or niobium wire, is removed in preparation for the next component or part of the electrode. The first component **62** is clamped between its first and second ends **72, 76** in the first collet.

As exemplified in FIGURE 6, a third collet **80** is indexed into position replacing the second collet. Of course it will be understood that the third collet may be the same, second collet illustrated in FIGURES 1-4 that now carries a supply of a second material **84**, such as, for example, molybdenum overwind used in the lamp electrode. The second material **°4** has a first end **88** that is presented by the third

collet and is referenced in a manner similar to that described with reference to FIGURE 1.

The second material **84** is advanced or indexed as depicted in FIGURE 7 so that a first end **88** of the second material is adjacent to the second end **76** of the first material. The first end **88** of the second material **84** is suitably positioned for joining the second material **84** to the first material component **62**. Preferably the materials are joined together by welding, forming a first weld **92**. However, other joining techniques can be used, such as, for example, crimping or bonding in environments other than forming a lamp electrode.

FIGURE 8 shows further advancing or indexing of the joined first material component **62** and the second material **84** through the first collet **40**. This subassembly is advanced a preselected distance **96** as a function of a desired length of the electrode.

Once advanced the preselected distance, the second material **84** is cut at a second material cutting position **104** (FIGURE 9) between the collets **40, 80**. While the first collet **40** preferably holds a portion of the second material **84** during the cutting operation, it is understood that the collet **40** could alternatively hold a portion of the first material component **62,** i.e., it is important that the subassembly is adequately supported while it is cut.

Upon completing the cutting operation, a first electrode sub-assembly **112** is defined and held in the first collet **40**. A second end **116** of the second material component **100** is defined as a result (FIGURE 10). The remainder of the second material is removed when the third collet **80** is indexed out of the way to make way for another collet (FIGURE 11).

A fourth collet **120** is next indexed into position to replace the third collet **80**. The fourth collet **120** carries a supply of a third material **124**, such as tungsten shank wire that is used to make the lamp electrode. A first end **128** of the wire **124** is referenced in a manner similar to that described above with respect to FIGURE 1. The first end **128** of the third material is advanced or indexed toward the

second end **116** of the second material component **100** as illustrated in FIGURE 13. Although a comparison of FIGURES 12 and 13 illustrates that the fourth collet is axially advanced toward the first collet, it will be appreciated that the third material can alternately be advanced by simply pushing the third material through fourth collet. In any event, the first end **128** of the third material **124** is brought into abutting engagement with the second end **116** of the second material component **100**. This suitably positions the component ends for joining, again, by forming a second weld **132**. While the figure shows the first collet **40** holding a portion of the second material component **100**, it is understood that it could be holding a portion of the first material component **62**.

Referring to FIGURE 14, the fourth collet **120** opens and moves axially over the third material (rightwardly as shown). This allows a guide device **136**, for example, a conventional clam-shell gripper with precision ground surfaces, to be positioned around the third material **124** and provide support while the third material **124** is cut at a third material cut position **140** (FIGURE 15). Again, the cut position **140** is a function of a desired length of the completed electrode (FIGURE 16). The first collet **40** holds a portion of the second material component **100**, although it is understood that the first collet could hold a portion of the first material component **62** and/or a portion of the third material **124**.

A second electrode sub-assembly **150** is defined and held in the first collet **40** once the third material is cut at a second end **154**. The fourth collet **120** is then moved away for additional manufacture of the electrode.

In FIGURE 18, a fifth collet **162** is moved into facing relation with the first collet. The fifth collet carries a supply of a fourth material, in the form of a tungsten coil **170**, having an inner diameter slightly smaller than an outer diameter **178** of the third material component **158**. The coil **170** has a first end **180** that is held at a preselected location in the fifth collet.

A guide **182** is brought between the first and fifth collets to ensure axial alignment of mating portions of the third material component **158** and the coil **170**. If

a guide is not used, it is beneficial to grip the third material component and the coil adjacent their respective ends **154**, **180** to provide tight positional control and axial alignment.

FIGURE 20 illustrates axial advancement of the coil **170** toward the second end **154** of the third material component. The coil is joined or secured to the second end **154** of the third material component **158** by pushing it over the third material component **158** a predetermined engagement distance **186**. The engagement distance **186** is a function of a desired final coil length of an electrode tip component **190** (see FIG. 22) of the electrode **38**.

After the coil is press fit onto the second end of third material component **158**, the coil **170** is cut at a coil cutting position **196** between the first collet **40** and the fifth collet **162**. The coil cutting position is determined by the desired length of the electrode tip **190** on the end of the electrode. Additionally, it may be beneficial to cut part of the second end **154** of the third material component **158** so the third material component **158** can act as a support for the coil **170** during the cutting process. The guide **182** also acts as a support during the cutting process.

FIGURES 22 and 23 illustrate the completed or manufactured electrode **E** held by the first collet **40**. The fifth collet **162** is indexed away from the first collet so that the complete electrode can be removed from the machine tool (see FIGURE 24).

FIGURE 25 shows an alternative method of securing the tip onto the electrode to that described above with reference to FIGURES 18-22. Rotating or spinning at least one of the third material component **158** and the coil **170** during the securement or engagement process aids in assembly. At least one of the components is rotated in a direction represented by arrows **192**, **194** so as to provide a force directed to unwinding or opening the coil **170**. For example, the coil **170** is held stationary by the fifth collet **162** and the third material component is spun by the first collet **40** in a direction opposite the helical lay of the coil **170** (as indicated by direction arrow **192**). As the inner surface of first end **180** of coil **170** makes contact with the outer surface

of the third component material **158** an unwinding or opening frictional force is applied to the inner surface of the coil **170**. This force tends to open the coil **170** facilitating further engagement. When the two components are mated the predetermined engagement distance **186** (see FIG. 20), rotation is terminated.

As noted above, the inner diameter **174** of the unmated coil is less than the outer diameter **178** of the third material component **158**. Additionally, the coil is made of material with spring-like characteristics. Therefore, when complete, the electrode tip component **190** (see FIG. 22) returns to its original diameter and tightly grips the outer diameter of the third material component. Thus, the two components **158**, **190** are press fit together.

The process may be further aided by forming a taper **198** in the second end **154** of the third material component **158**. Tapering can be accomplished with an added grinding, hot neck-down, or other appropriate tip shaping step (not shown). The taper provides a locating or centering feature of the third material component into the coil so that the helix is progressively opened as it axially advances thereover.

The invention has been described with reference to a preferred embodiment. Obviously modifications and alterations will occur to others upon reading and understanding this specification. For example, the electrode can be made in the reverse order from that described. The third material component and coil portion can be manufactured separately and placed in the collet with another mechanism. Likewise, fewer than all of the described components can be used to make the electrode or additional components can be included. Alternatively, the coil can be plasma or resistance welded to the third material component to further strengthen its adhesion. Moreover, although the process steps are illustrated as being conducted in a horizontal direction, the orientation is not critical to practice of the invention. While the described embodiment makes use of a plurality of collets, it is understood that other embodiments may use two or fewer collets. The invention is intended to include all such modifications and alterations insofar as they come within the scope of the appended claims and equivalents thereof.